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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/023,125	12/17/2001	Jong Hyun Yoo	AMAT/5730	4585

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EXAMINER	
SMITH, FRANCIS P	

ART UNIT	PAPER NUMBER
1792	

MAIL DATE	DELIVERY MODE
11/19/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/023,125	YOO ET AL.	
	Examiner	Art Unit	
	Francis P. Smith	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 December 2001*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *9/2/2008*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments with respect to claims 1-24 have been considered but are moot in view of the new ground(s) of rejection.

Applicants argue that Rajagopalan does not teach or show controlling production of a concentration boundary layer or the removal of the process gas lasting from about 3-12 seconds. The examiner respectfully disagrees. Rajagopalan teaches the removal of process gas after the nucleation step to remove residual tungsten hexafluoride (i.e. removing said process gas) via a purge step lasting 5 seconds (i.e. removing said process gas from a process chamber that lasts from about 3-12 seconds) (pg. 12, line 31-page 13, line 3). Thus, since Rajagopalan teaches substantially the same processing steps as the instant application, Rajagopalan teaches controlling production of a concentration boundary layer. Furthermore, it is axiomatic that one who performs the steps of a process must necessarily produce all of its advantages and the mere recitation of a newly discovered property that is inherently possessed by the steps in the prior art does not cause a claim drawn to those steps to distinguish over the prior art.

Claims 1, 2, and 14 are currently amended. Claims 25-30 are canceled. Claims 1-24 are currently pending and examined on the merits.

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

3. Claims 1, 2, 4, 7-9, 11-19, 21, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rajagopalan et al. (WO 98/51838) and further in view of Govindarajan et al. (US 6,309,966 B1).

Rajagopalan teaches a multiple step chemical vapor deposition process for depositing a tungsten layer on a substrate. For claims 1, 4, 11, 14, and 17 a substrate is heated (pg. 12, lines 25-26);

a process gas consisting a metal source (tungsten hexafluoride) and a hydrogen source (silane) (claims 11 and 17) are introduced into and removed from a processing chamber (i.e. controlling production of a concentration boundary layer by removing said process gas from said processing chamber after commencement of nucleation of said substrate) (pg. 11, lines 20-26);

wherein removing said process gas from said process chamber lasts from about 3 to about 12 seconds (via an Ar purge step, as per claims 4 and 21) (pg. 13, lines 1-3). Rajagopalan, however, does not expressly teach a substrate having openings for forming one or more vias or nucleating said substrate with metal within the openings. It is well known in the semiconductor industry for semiconductor substrates to have said

openings/vias. Govindarajan teaches a method of a low pressure, two-step nucleation tungsten deposition to nucleate/fill vias within a semiconductor substrate (see abstract). Specifically, the first nucleation layer is deposited to nucleate uniformly on all surfaces (e.g. within the via) (col. 7, lines 38-50). Therefore, it would have been well within the level of ordinary skill to utilize Govindarajan's substrate in Rajagopalan's method to achieve the predictable result of fabricating an integrated circuit with the reasonable expectation of success.

Regarding claims 9 and 16, a layer of tungsten metal is bulk deposited after the nucleation step with a layer of tungsten of desired thickness (i.e. forming, after introducing into, and removing from, said processing chamber, a bulk deposition layer of metal) (pg. 11, line 27- pg. 12, line 4).

As for claims 12 and 18, during a setup step before nucleation, the substrate is heated to a temperature of 425°C at an initial pressurization of 30 torr. The chamber pressure is reduced to 3.0 torr just before nucleation (i.e. establishing an initial pressurization in said processing chamber before introducing into and removing from said processing chamber said processing gas, with the initial pressurization being greater than the first pressurization) (pg. 12, lines 22-30).

For claims 13 and 19, silane (said hydrogen source) is introduced into the chamber while establishing said initial pressurization (pg. 12, lines 25-28).

Addressing claims 2 and 15, Rajagopalan does not explicitly teach introducing and removing occurs multiple times to nucleate said substrate with a layer of metal of a desired thickness (claims 2 and 15).

Govindarajan teaches an apparatus and method of tungsten via fill using a low pressure, two-step nucleation tungsten deposition process. Specifically, the deposition process recipe includes multiple step nucleation film growth (col. 5, lines 13-20). The first nucleation serves to permit as seed layer to nucleate uniformly on all the surfaces of the substrate (e.g. within the openings) while the subsequent nucleation provides a more accurate controllability to optimize the overall nucleation film thickness (col. 7, lines 38-50). Therefore, it would have been obvious to one skilled in the art at the time of the invention to utilize Govindarajan's multiple nucleation steps in Rajagopalan's method in order to control the uniformity and thickness of the nucleation layer prior to subsequent tungsten bulk deposition.

For claim 7, Rajagopalan does not expressly teach introducing said process gas for 3-5 seconds and removing said process gas after 7-12 seconds. However, it is noted that processing parameters such as specific times are considered result effective in the absence of critical notification of a specific time. As for the times for introducing and terminating the process gas, the time will be directly related to the flow rates of the process and purge gases. A greater flow rate will require less time for introducing and terminating, while a lesser flow rate will require more time. Furthermore, the discovery of optimum values of result effective variables in known processes would have been obvious to a person of ordinary skill in the art at the time of the invention in the absence of unexpected results. Consult *In re Boesch and Slaney (205 USPQ 215 (CCPA 1980)).*

Regarding claims 8 and 24, Rajagopalan does not expressly teach repeating

nucleation cycles to form a nucleation layer of tungsten upon the substrate while varying a ratio of said metal/tungsten source with respect to said hydrogen source during successive nucleation cycles.

Govindarajan teaches a control system that instructs the tungsten-containing gas source and the silane-containing gas source to flow a sufficient amount of gas mixture that results in a first silane-rich nucleation site layer for the subsequent second nucleation film growth and the bulk tungsten film deposition. The control system instructs the silane-containing gas source and the tungsten-containing gas source to flow silane and tungsten hexafluoride at a ratio within the range of approximately 2:1 - 7:1 for the first nucleation, and to flow silane and tungsten hexafluoride at a ratio of 1:2 for the second nucleation to optimize overall nucleation film thickness (col. 6, lines 1-20; lines 37-53). Therefore, it would have been obvious to one skilled in the art at the time of the invention to utilize Govindarajan's multiple nucleation steps with process gasses varying in ratio in Rajagopalan's method in order to form the appropriate seed layers and optimize overall nucleation film thickness prior to bulk deposition of the tungsten film.

4. Claims 3, 5, 6, 10, 20, 22, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rajagopalan et al. (WO 98/51838) and Govindarajan et al. (US 6,309,966 B1) as applied to claims 1 and 14 above, and further in view of Tseng et al. (EP 0704551).

Rajagopalan/Govindarajan teach establishing an initial pressure of 30 torr while

introducing a hydrogen source into the chamber (pg. 12, lines 25-30). A pressure control subroutine is utilized that contains a program code for controlling the pressure in the chamber by regulating the size of the opening of the throttle valve in the exhaust system of the chamber (pg. 9, line 30-pg. 10, line 12). Prior to/during nucleation, the chamber pressure is reduced to 3 torr (pg. 12, lines29-30). After the nucleation step, the chamber is purged to remove the remaining process gases (pg. 12, lines 31-pg. 13, line3). Rajagopalan/Govindarajan does not expressly teach pressurizing the chamber to a second pressure level less that the first pressure level (claims 3 and 20), maintaining a pressurization of said chamber at a constant level (claims 5 and 22), introducing a purge gas into said chamber while decreasing a pressurization of said chamber (claims 6 and 23).

Tseng teaches a method of processing semiconductor wafers in a vacuum processing chamber utilizing silane and tungsten hexafluoride as processing gases. Specifically, during the purging of the chamber, a purge gas is flowed while the chamber pressure is maintained. A second purge/pumping of the reaction chamber and process gas feed lines is conducted at a reduced pressure (col. 7, lines 52-59; col. 8, lines 17-25). Therefore, it would have been obvious to maintain or reduce the pressure while purging the reaction chamber as taught by Tseng in Rajagopalan/Govindarajan's method in order to ensure all reactive species are removed from the processing area.

As for claim 10, Rajagopalan/Govindarajan/Tseng do not expressly teach a first pressurization of 15 torr and a second pressure level of 1-3 torr. However, it is noted that this processing parameter is considered result effective in the absence of critical

notification of a specific pressure. A lower pressure will allow for ease of substrate de-chucking when removing or transferring the substrate between reaction chambers, while a higher pressure will prevent contamination of the substrate. Furthermore, the discovery of optimum values of result effective variables in known processes would have been obvious to a person of ordinary skill in the art at the time of the invention in the absence of unexpected results. Consult *In re Boesch and Slaney (205 USPQ 215 (CCPA 1980)).*

Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Francis P. Smith whose telephone number is (571) 270-3717. The examiner can normally be reached on Monday through Thursday 7:00 AM-5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mikhail Kornakov can be reached on (571) 272-1303. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/F. P. S./
Examiner, Art Unit 1792

/Michael Kornakov/
Supervisory Patent Examiner, Art Unit 1792